and we find that the cortex cells are round and have many spaces between the cells, while fig. 19 represents the roots of *Actæa alba*, which grows on dry banks, and here the cortex cells are angular and the spaces between cells are almost none. The differences in vascular development are also well shown in these figures.

In this part of the paper I have not discussed the general structure of the species studied as regards the occurrence and distribution of the histological elements, since I find that Marie, Hegelmaier, and others have described the general structure of many species of *Ranunculaceæ*, and in many cases my descriptions would have been but a repetition of theirs.

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Flowers and insects. X.

CHARLES ROBERTSON.

STEIRONEMA LANCEOLATUM Gray.—The plants are commonly collected in small patches. They grow 3 or 4^{dm} high, and expose a few yellow flowers with reddish-purple centers. The flowers look outwards and a little downwards, and expand from 20 to 25^{mm}. In the bud each corolla lobe enfolds an anther. When the flower expands, the lobes carry the enclosed anthers with them, holding them while the stigma is receptive and is exposed to insects—a fact to which my attention was first called by Professor Pammel. After the anthers are released, the styles are commonly found bent outwards, out of the way of the falling pollen. Sprengel supposed that flowers of *Lysimachia quadrifolia* were nectar bearing, but failed to find nectar. He, and Müller also, failed to find honey in flowers of *L. vulgaris*. According to Kirchner nectar is wanting in *L. nemorum* as well as in *L. nummularia*. I have been uncertain in regard to the occurrence of honey in Steironema, but the visits of male bees seem to indicate its presence, although these insects might search for it in vain. They commonly fly about the flowers to find the females, not trying to find honey.

I have noted the flowers in bloom from June 20th to July 12th. As far as I have observed, they are visited for honey and pollen only by *Macropis steironematis* Rob. ♂♀.

STEIRONEMA LONGIFOLIUM Gray.—This plant resembles the preceding, but grows somewhat taller and bears a greater profusion of flowers. The flowers are without purplish centers. They appear more homogamous, the anthers being more readily released by the lobes, and the style not being bent aside. The flowers were noted in bloom from July 26th to August 23d. The only visitors observed were *Macropis steironematis* Rob. ♂♀, c. p., and perhaps s., abundant, and *Halictus confusus* Sm. ♀, c. p., once.

The flowers of Lysimachia and Steironema seem to hold, as regards their economy, an important mutual relation with bees of the genus *Macropis*. In the "Fertilization of Flowers" Müller states that he found the females of *Macropis labiata*, as a rule, only on flowers of *Lysimachia vulgaris*, and the only other cases cited in that work of the occurrence of *Macropis* on flowers are the visits of the males to flowers of *Œnanthe fistulosa*, *Rhamnus Frangula*, *Melilotus alba* and *Rubus fruticosus*. The other insects observed by Müller on *L. vulgaris* were rare and their visits evidently have no significance. In the Entomologist's Monthly Magazine, XVII, 31–35, Mr. W. H. Patton states that in Connecticut he found *Macropis ciliata* ♀ on flowers of *Steironema ciliatum*, *Rhus glabra*, *R. typhina* and *Archangelica hirsuta*, but says nothing about them collecting pollen. The male was captured on flowers of *Rubus villosus* and *Cornus paniculata*. *M. patellata* ♂ was taken on flowers of either *Cicuta* or *Rhus* and on *Steironema ciliatum*. I have taken *M. steironematis* on flowers of *Ceanothus Americanus*, *Apocynum cannabinum* and *Melilotus alba*, but I have never seen the female collecting any pollen except that of Steironema. We have here a case which as far as mutual dependence goes bears a strong resemblance to the case of Yucca and Pronuba.

FRASERA CAROLINENSIS Walt.—The plants are frequent on rich hillsides, blooming, as far as observed, from May 26th to June 12th. The stem grows as high as two meters, and bears an immense panicle of pale-greenish flowers, which measure about 35^{mm} across.

The flowers are pendulous. The four lanceolate petals expand horizontally. They have whitish bases and greenish tips. On the middle of each petal, about 3^{mm} from its base, is situated a peculiar nectariferous depression, which is oval in outline, about 4^{mm} long by 3^{mm} wide and 1^{mm} deep. This is sur-

rounded by a dense circle of hairs, which form a crest over the cavity and completely conceal the nectar. Some of the hairs are bent downwards, and their tips are turned into the cavity. Besides concealing the nectar from small short-tongued intruders which could not effect pollination, the hairs serve as foot-holds for insects to cling to when extracting the sweets. About this nectary the petals are purple-dotted—the dots serving as path-finders.

Four divergent stamens about 13^{mm} long alternate with the petals, while the stigma occupies the center of the circle. Self-pollination is prevented by the strong proterandry.

When an insect clings to one of the crested nectaries, its body is fairly certain to touch the anthers on that side, as well as the stigma. The size of the flower, however, indicates that the insect, in order to do this, must be of large size. I expected to see the flowers visited by bumble-bees, which, after all, may prove to be the principal visitors, but after watching them on June 10th and 11th the only insect observed sucking, which could effect pollination, was *Polistes metricus* Say ♀. It clings to the stamens and style with its posterior legs and can readily strike the anthers and stigma. *Halictus coriaceus* Sm. ♀ visits the flower for honey and pollen, but is too small to do any good.

ELLISIA NYCTELEA L.—The plant is common, rises about 2^{dm}, is scattered in thin patches, and is commonly rendered quite inconspicuous by the surrounding vegetation. The rather diffuse branches bear only a few flowers, which bloom in succession, so that, in their visits, insects are as likely to pass between flowers of distinct plants as from flower to flower on the same plant. The flowers vary in position from erect to pendulous, the calyx lobes, which equal the corolla in length, often concealing it from view.

The corolla measures about 4 or 5^{mm} in length and expands about 6^{mm}. The tube is about 4^{mm} long and is as wide as 2^{mm}, so that it readily admits the head and thorax of small bees. The border is turned out nearly horizontally and is divided into five rounded lobes. With the exception of three to five purplish dots on the middle of the lobes, the color is white. A few hairs on the inner wall of the corolla tube seem to have little significance.

Five stamens alternate with the corolla lobes and bend to the center of the flower, so that to reach the nectar, insects

are required to insert their tongues between the filaments. Each filament has on each side of its base a fimbriate appendage which tends to close the interval. Then the ovary is densely clothed with erect bristle-like hairs which also aid in concealing the nectar. The disk surrounding the base of the ovary shows five nectar secreting processes alternating with the filaments.

The flower is homogamous. The style with its receptive stigma rises among the dehiscent anthers, being generally overtopped by them, so that self-pollination may readily occur with or without insect aid.

Probably on account of strong competition with its allies and other plants the flower seems to have gone through a stage in which it was neglected by insects and was compelled to rely upon self-pollination. At present I find it abundantly visited, to an extent that would seem to justify the return of dichogamic characters.

But the damp shady situations in which the plant grows, no doubt, render the visits of insects quite uncertain, so that the power of spontaneous self-pollination becomes a most important condition of selection. The flower is adapted to small bees, especially *Halictus*. It blooms from April 21st to June 21st. May 8th, 12th and 21st the following visitors were observed:

Hymenoptera—*Apidae:* (1) Ceratina tejonensis Cr. ♂, ab.; (2) C. dupla Say ♂♀, ab.; (3) Osmia albiventris Cr. ♂; (4) O. atriventris Cr. ♂♀; (5) Nomada maculata Cr. ♀; *Andrenidae* (6) Andrena violae Rob. ♀; (7) A. ziziae Rob. ♂; (8) Augochlora pura Say ♀, ab.; (9) Halictus 4-maculatus Rob. ♀, ab.; (10) H. pectoralis Sm. ♀; (11) H. fasciatus Nyl. ♀, ab.; (12) H. obscurus Rob. ♀, ab.; (13) H. zephyrus Sm. ♀; (14) H. tegularis Rob. ♀; (15) H. stultus Cr. ♀—all s.

Diptera—*Bombylidae:* (16) Bombylius pulchellus Lw., s.; (17) B. fratellus Wd., s.; *Syrphidae:* (18) Pipiza femoralis Lw., f. p.; (19) Mesograpta marginata Say, f. p.; (20) M. geminata Say, f. p.; (21) Rhingia nasica Say, s.

COMANDRA UMBELLATA Nutt.—The flower is remarkable for being specially adapted to flies. The calyx is white and expands about 5^{mm}. It is generally 5-, sometimes 3- or 4-parted. The tube is 2 or 3^{mm} long, lined within by a green disk which above forms lobes alternating with the stamens and calyx lobes. This disk, especially at its exposed lobes, secretes

nectar which is very attractive to flesh-flies. Visitors have abundant pollen massed about the bases of their proboscides.

The flowers are homogamous. The stigma somewhat surpasses the anthers and is separated from them. I do not think spontaneous self-pollination occurs, unless it be in bad weather.

The plants are common, often in large patches, grow from 1 to 2^{dm} high and expose an umbel-like cluster of flowers. The flowers bloom from April 27th to June 6th. The following list of visitors was observed on May 12th, 16th, 17th, and 19th:

Diptera—*Syrphidae:* (1) Sphaerophoria cylindrica Say, ab.; (2) Volucella vesiculosa F.; (3) Eristalis dimidiatus Wd.; (4) Helophilus latifrons Lw.; (5) Tropidia mamillata Lw.; (6) Syritta pipiens L.; *Tachinidae:* (7) sp.; (8) Trichophora echinomoides Twns.; (9) Gonia frontosa Say; *Sarcophagidae:* (10) Cynomyia sp., very ab.; (11–13) Sarcophaga spp., very ab.; *Muscidae:* (14) Calliphora erythrocephala Mg., freq.; (15) C. vomitoria L.; (6) Lucilia sp., very ab.; (17) L. caesar L., ab.; (18) L. latifrons Schin., freq.; (19) L. sericata Mg., two; (20) L. cornicina F.; (21) L. sylvarum Mg., very ab.; (22) Graphomyia sp.; (23) Myospila meditabunda F.; *Anthomyidae:* (24) Limnophora sp., ab.; (25) Chortophila sp.; (26) Coenosia sp.; *Sciomyzidae:* (27) Tetanocera sp.—all sucking.

Hymenoptera—*Apidae:* (28) Apis mellifica L. ☿; (29) Synhalonia speciosa Cr. ♂; (30) Osmia albiventris Cr. ♀; (31) Nomada superba Cr. ♂; *Andrenidae:* (32) Andrena sayi Rob. ♀; (33) A. flavo-clypeata Sm. ♀: (34) A. mariae Rob. ♀; (35) Halictus lerouxii Lep. ♀; (36) H. confusus Sm. ♀; (37) H. albipennis Rob. ♀; (38) H. tegularis Rob. ♀; (39) Sphecodes arvensis Pttn. ♀—all sucking, rare.

Coleoptera—*Coccinellidae:* (40) Megilla maculata DeG., one; *Lampyridae:* (41) Telephorus bilineatus Say, one—both sucking.

SPIRANTHES GRACILIS Bigelow.[1]—The flowers are white and measure 4 or 5^{mm} long. The parts of the perianth, with the exception of the divergent lower sepals, are disposed so as to limit access to the nectar. The upper sepal is connivent with the two upper petals, forming the upper wall of the tube. At their free ends these parts form a three-toothed upper lip. The lower wall is formed by the labellum, whose

[1]See Darwin: Fertilization of Orchids; Gray: Am. Journ. Sci., xxxiv.

tip forms a lower lip. This is too small to form a landing-place for insects, but makes the flower a little more conspicuous. A proboscis about 4^{mm} long can drain the nectar with ease.

In Gray's Manual the time of blooming is stated to be from July to October, while in Chapman's Flora of the Southern States it is said to be in April and May. In Illinois I have found the plant in bloom in September. At Orlando, Florida, I noted it in bloom from February 18th to March 16th, and at Inverness, Citrus county, from March 15th to 23d. In Illinois I have seen the flowers visited by *Bombus americanorum* F. ♂ and *Calliopsis andreniformis* Sm. ♀. At Orlando, Florida, I saw them visited by a bee which I failed to capture, but which I supposed was *Anthidium notatum* Latr., and by *Megachile brevis* Say ♂.

The last mentioned insect has two boat-shaped discs with attached pollinia fastened to the maxillary laminæ, and I think this is the particular part of a bee to which the flower is adapted to fasten its pollinia. At Torquay, Darwin saw *S. autumnalis* visited by two species of bumble-bees. In one specimen which he examined he states that the pollinia were attached to the superior (maxillary) laminæ. The maxillary laminæ are on the upper side when the proboscis is inserted into a flower, and are the parts which would be expected to touch the disk first. But the most important consideration is that when the bee's proboscis is folded up under the head, the maxillary laminæ fall into such a position that the pollinia retain their hold without danger of being disturbed.

ORCHIS SPECTABILIS L.[2]—In my neighborhood there are many places favorable for the protection of this Orchis, and it is of rather frequent occurrence. It is found on north hillsides in rather shady places. The scapes grow from 1 to 2^{dm} high and bear several flowers. The labellum with its spur is white. It is nearly pendant and measures from 10 to 15^{mm} long by 8 to 10^{mm} wide. The other parts of the parianth are united into a purplish helm which effectually shelters the column and the mouth of the spur. The spur is from 12 to 15^{mm} long, is somewhat enlarged near the tip, and the nectar rises 2 to 3^{mm}.

The flower is specially adapted to *Bombus* females. At the

[2] See Guignard: 16th ann. rep. Ent. Soc., Ontario; Mignault: Bemerkungen über die Befruchtung der Pflanzen.

time when it blossoms (May) only the females of *Bombus* are flying. The disks are applied to the bee's clypeus, which in the female is bare. The clypeus of the male is so hairy that the disks could hardly be properly fastened to them. Long-tongued species of *Anthophora* and *Synhalonia* are flying while the flowers bloom and can reach the nectar, but I do not believe the flowers are adapted to them, because the males, which fly at the same time, have hairy faces, and they would be as apt to visit the flowers. When the pollinia are withdrawn by a bee they stand in a nearly horizontal position, since the bee's clypeus has its face directed nearly vertically, so that in moving downwards to a position in which they will strike the stigma they must be assisted by their own weight.

On May 13th I found a patch of five plants, which bore twenty flowers. With the exception of three flowers, the pollinia were removed from all, and most of the stigmas had received pollen. I saw the flowers visited by the females of *Bombus separatus* Cr. and *B. americanorum* F. The proboscis of the former can drain the short-spurred flowers and obtain some of the nectar which rises in the long spurs. *Bombus americanorum* can easily exhaust the longest spurs. A specimen of this bee which I captured at the flowers has a pair of pollinia on the clypeus.

HABENARIA LEUCOPHÆA Gray.—The plant is rare. It grows on prairies. The stem rises from 4 to 8^{dm} and bears a raceme of greenish white flowers. The flower measures about 20^{mm} long by 15^{mm} wide.

The upper sepal and two upper petals form a galea which shelters the anther. The labellum is three parted, each division being fimbriate. The disks are set one on each side of the entrance to the spur and are separated about 2^{mm}, so that when the hawk-moth throws its proboscis to one side or the other, it is apt to remove one of the pollinia, but is not likely to extract both of them. The spur is very slender and measures from 35 to 40^{mm} in length, indicating that the flower is adapted to Sphingidae. The nectar does not seem to be enclosed between the walls of the spur but appears to occupy the cavity. The height to which it rises can be seen from the outside. Sometimes it fills the spur for 10^{mm} above the tip.

I have found the plant in bloom from June 12th to July 12th. July 2nd I captured at the flowers a specimen of *Chaero-*

campa tersa L. with three disks on its proboscis, about 4[mm] from the base. At Champaign, Ill., Mr. M. B. Waite showed me a specimen of *Philampèlus achemon* Dru., which he had taken on the flowers. It had pollinia about 5[mm] from the base of the proboscis.

Carlinville, Illinois.

Notes on North American Umbelliferæ. III.

JOHN M. COULTER and J. N. ROSE.

WITH PLATE V.

The two preceding papers of this series were published in this journal November, 1889, and October, 1890. The present paper is a report upon the Umbelliferæ of Mr. John Donnell Smith's third distribution of Guatemalan plants. Most of the species were sent by H. Th. Heyde and Ernst Lux, who have made extensive collections for Mr. Smith. We have previously reported upon Guatemalan Umbelliferæ in this journal for January and October, 1890.

HYDROCOTYLE MEXICANA Cham. & Schl.—Rio Negro, Dept. Quiché, at an altitude of 3,600[ft], June, 1892, no. 3,350. Collected by Heyde & Lux.

HYDROCOTYLE PROLIFERA Kell.—Amatitlan, Dept. Amatitlan, at an altitude of 3,990[ft], May, 1892, no. 2,668. Collected by John Donnell Smith. This seems to be the same species collected at this place by Mr. Smith in 1889, and referred to in BOT. GAZ. XV. 259. Also from Santa Rosa, Dept. Santa Rosa, at an altitude of 3,000 to 4,000[ft], April, 1892, no. 3,349. Collected by Heyde & Lux. This plant is less proliferous, the umbel sometimes being simple as in *H. umbellata.*

SPANANTHE PANICULATA Jacq.—Santa Rosa, Dept. Santa Rosa, at an altitude of 3,000 to 4,000[ft], June 1892, no. 3,351. Collected by Heyde & Lux.

ERYNGIUM CARLINÆ Delar.—San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to 12,000[ft], April, 1892, no. 3,356. Collected by Heyde & Lux.

SANICULA MEXICANA DC.—San Miguel Uspantán, Dept. Quiché, at an altitude of 6,000 to 12,000[ft], April, 1892, no. 3,357. Collected by Heyde & Lux.